1. 1990/I/1b

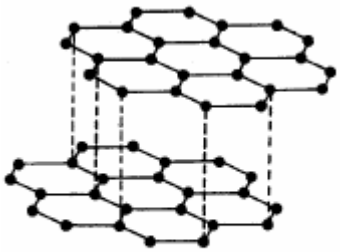


Diagram I : an allotrope of carbon

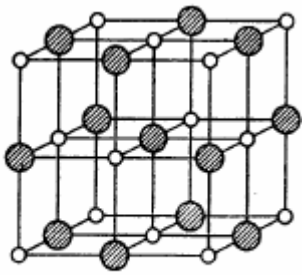


Diagram II : sodium chloride

The two diagrams above represent part of the structure of an allotrope of carbon, and sodium chloride at room temperature.

(i) What type of bonding exists in each of the substances shown above?

(ii) State a condition under which each substance can conduct electricity. Explain your answers

(iii) Name an allotrope of carbon other than that shown above.

(iv) Which allotrope of carbon is used to

(1) make pencil lead?

(2) cut glass?

Explain your answers with reference to the difference arrangements of atoms in these two allotropes.

(v) Do you agree with the statement "sodium chloride cannot easily be changed into sodium and chloride"? Explain your answer. (12 marks)

2. 1991/I/1a

The following is a part of the Periodic Table :

	Group							
	I	II	III	IV	V	VI	VII	0
Second period				*a*			*b*	
Third period	*c*		*d*			*e*	*f*	*g*

Referring to the letters indicated in the above table, answer the following questions :

(i) (1) What is the name for the family of elements of which *b* and *f* are members ?

(2) In what way are the electronic arrangements of the atoms of elements *b* and *f*

(I) similar to each other ?

(II) different from each other ?

(ii) Element *d* has a higher melting point than element *c*. Explain.

(iii) The oxide of element *d* is insoluble in water and amphoteric.

(1) Give the formula for this oxide.

(2) Suggest suitable chemical tests to show that the oxide is amphoteric.

(iv) Two elements in the above table have allotropes.

(1) Explain the meaning of 'allotropes'. (*Out of syll.*)

(2) Suggest what the two elements are.

(v) Element *e* can form compounds with elements (((a and c))) separately.

(1) Draw the electronic structures of these two compounds, showing the outermost electrons ONLY.

(2) Which of these two compounds has a higher melting point ? Explain your answer. (13 marks)

3. 1992/I/3b

Neon, a monatomic gas, occurs naturally as a mixture of three isotopes. The relative abundance of these isotopes is tabulated below :

Isotope	$^{20}_{10}$Ne	$^{21}_{10}$Ne	$^{22}_{10}$Ne
Abundance (%)	90.52	0.31	9.17

(i) State the number of electrons in the outermost shell of a neon atom.

(ii) Explain why neon gas is monatomic.

(iii) What is meant by the term 'isotope' ?

(iv) Calculate

(1) the relative atomic mass of neon.

(2) the density (in g dm^3) neon gas at room temperature and pressure.

(Molar volume of gas at room temperature and pressure = 24.0 dm^3) (7 marks)

4. 1993/I/2b

Physical properties of substances depend mainly on the types of binding force between their constituent particles.

(i) The melting points of diamond and tetrachloromethane are 3750^{o}C and -23^{o}C respectively. Explain the difference in their melting points.

(ii) In their solid states, sodium conducts electricity but sodium chloride does not. Explain.

(iii) Explain why tetrachloromethane does not conduct electricity in liquid state. (5 marks)

5. 1993/I/4a

The following table has given some information about W, X, Y and Z which represent particles of some elements. These particles are either atoms or ions.

	Mass number	Atomic number	No. of protons	No. of electrons	No. of neutrons
W		12		12	12
X			12	10	12
Y	35	17		17	
Z			17	17	20

(i) In which group of the Periodic Table should W be placed ? Explain your answer.

(ii) (1) What is the relationship between W and X ?

(2) Suggest a chemical reaction which can change W into X.

(iii) Molecules of Y and of Z are both diatomic.

(1) Draw the electronic structure of a molecule of Y, showing electrons in the outermost shells only.

(2) Do molecules of Y and of Z have the same chemical properties ? Explain your answer.

(iv) W can form a compound with Z. Calculate the formula mass of the compound formed.

(7 marks)

6. 1994/I/7b

The table below lists some physical properties of lead, bromine and lead(II) bromide.

	Lead	Bromine	Lead(II) bromide
Melting point	328°C	–7 °C	370 °C
Electrical conductivity in the solid state	conducting	non-conducting	non-conducting
Electricity conductivity in the liquid state	conducting	non-conducting	----

(i) Explain the difference in melting points between bromine and lead(II) bromide.

(ii) Explain the difference in electrical conductivity between lead and lead(II) bromide in the solid state.

(iii) Will lead(II) bromide conduct electricity in the liquid state ? Explain your answer. (5 marks)

7. 1995/I/1

Rubidium (Rb) and potassium belong to the same group in the Periodic Table. The relative atomic mass of rubidium is larger than that of potassium.

(a) Explain whether rubidium is more reactive than potassium.

(b) Write a chemical equation for the reaction between rubidium and water. (State symbols should be given)

(c) Suggest how rubidium can be stored safely in the laboratory.

(d) Suggest ONE safety precaution for handling rubidium in the laboratory. (5 marks)

8. 1995/I/2a,d

In each of the following groups of substances, there is ONE substance which is different from the others in terms of their properties. In each group, identify the substance which is different from the others and explain your choice.

(a) argon, fluorine, helium, neon

(d) carbon monoxide, hydrogen, methane, nitrogen (4 marks)

9. 1996/I/7a

The boxes below show some information about two atoms, hydrogen (H) and deuterium (D) :

Mass number	→	1	Mass number	→	2
		H			D
Atomic number	→	1	Atomic number	→	1

(i) Suggest a term to indicate the relationship between a hydrogen atom and a deuterium atom.

(ii) State the number of neutrons in a deuterium atom.

(iii) Deuterium reacts with oxygen in the same way as hydrogen.

$2D_2(g) + O_2(g) \rightarrow 2D_2O(\ell)$ ΔH is negative

The product of the reaction is known as 'heavy water'.

(1) Explain why deuterium reacts with oxygen in the same way as hydrogen.

(2) Draw the electronic structure of 'heavy water', showing electrons in the outermost shells **ONLY**.

(3) What is meant by 'ΔH is negative'?

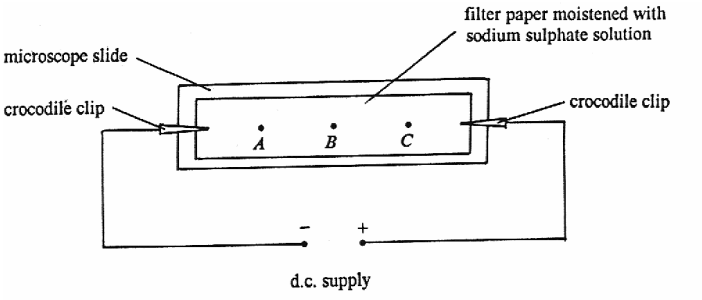
(4) What is the formula mass of 'heavy water'?

(5) 100 cm^3 of deuterium and 100 cm^3 of oxygen, both measured at room temperature and pressure, are allowed to react. Calculate the mass of 'heavy water' produced.

(Relative atomic masses : O = 16.0; Molar volume of gas at room temperature and pressure = 24.0 dm^3) (9 marks)

10. 1997/I/6a

A student used the following experimental set-up to study the migration of ions.



The student placed a drop of potassium dichromate solution at *A* and a drop of a deep blue solution at *C*. It is known that the two solutions do not react and the deep blue colour of the solution at *C* is due to the cation present.

(i) Write the formula of the ion responsible for the orange colour of the potassium dichromate.

(ii) Why was the filter paper moistened with sodium sulphate solution?

(iii) An electric current was passed through the circuit for some time.

(1) What would be the colour change at *A*?

(2) What would be the colour change at *B*? Explain your answer.

(iv) Using the same apparatus and materials, suggest how you could show that the colour changes in (iii) are **NOT** due to diffusion. (8 marks)

11. 1998/I/1

Lithium is a Group I element in the Periodic Table. It occurs naturally in two isotopic forms. The relative abundance of each of these isotopes is shown in the table below:

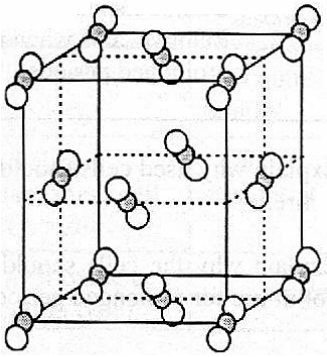
Isotope	^{6}Li	^{7}Li
Relative abundance (%)	7.4	92.6

(a) What is the meaning of the term 'isotope' ?

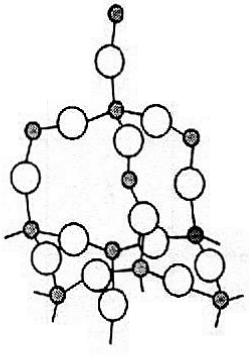
(b) Calculate the relative atomic mass of lithium. (3 marks)

12. 1998/I/7a

Both carbon and silicon are Group IV elements in the Periodic Table. The diagrams below show the structures of dry ice (solid carbon dioxide) and quartz (a form of silicon dioxide):



dry ice



quartz

(i) With reference to the structures of the two substances, explain why quartz is a solid which melts at a high temperature, while carbon dioxide is a gas at room temperature.

(ii) With the help of a labelled diagram, suggest how to show experimentally that dry ice sublimes to give gaseous carbon dioxide.

(iii) Sand (an impure form of quartz) and limestone are raw materials used for making glass.

(1) Name the main chemical constituent of limestone.

(2) Suggest ONE reason why glass had been used by mankind for a long time.

(3) Suggest ONE reason why glass bottles are preferred to plastic bottles for the storage of champagne. (9 marks)

13. 2000/I/1

Six compounds are classified into two groups as shown in the table below :

Gas	Solid
ammonia	iron(III) oxide
carbon dioxide	magnesium oxide
nitrogen dioxide	potassium oxide

Reclassify these compounds into two groups according to

(a) one of their physical properties, and

(b) one of their chemical properties. (4 marks)

14. 2000/I/2

The table below lists some information about four elements, *W*, *X*, *Y* and *Z*:

Element	Atomic number	Relative atomic mass
W	16	32.1
X	18	39.9
Y	19	39.1
Z	20	40.1

(a) What is the meaning of the term 'relative atomic mass' ?

(b) State, with explanation, which of the above elements

(i) should be stored under paraffin oil.

(ii) is used to fill a light bulb.

(iii) forms an oxide which dissolves in water to give a solution with pH less than 7. (8 marks)

15. 2000/I/8ci

State whether each of the following statements is true or false. Explain your answer in each case.

The melting point of sodium chloride is much higher than that of methane because the ionic bonding in sodium chloride is much stronger than the covalent bonding in methane. (2 marks)

16. 2001/I/8a

A part of the Periodic Table is shown below:

		Group							
		I	II	III	IV	V	VI	VII	O
Period	2	Li	Be	B	C	N	O	F	Ne
	3	Na	Mg	Al	Si	P	S	Cl	Ar
	4	K	Ca					Br	Kr
	5								Xe

(i) Across a period, the elements demonstrate a gradual change in some of their physical properties. State ONE such property.

(ii) For each of the following pairs of elements, suggest ONE reaction in which both elements behave similarly. In each case, write a chemical equation for the reaction involving either one of the elements.

(1) magnesium and calcium

(2) chlorine and bromine

(iii) Lithium metal is used in making dry cells. State, with explanation, whether lithium acts as the anode or cathode in these cells.

(iv) Xenon (Xe) is a Group O element. State, with explanation, what will happen if a balloon filled with xenon is released from the top of a tower.

(Relative atomic masses: N = 14.0, O = 16.0, Xe = 131.3) (9 marks)

17. 2002/I/1ci

Calculate the percentage by mass of nitrogen in ammonium sulphate. (3 marks)

18. 2002/I/6b

Magnesium occurs naturally in three isotopic forms. The relative abundance of each isotope is shown in the table below:

Isotope	^{24}Mg	^{25}Mg	^{26}Mg
Relative abundance (%)	78.6	10.1	11.3

(i) State the meaning of the term 'isotopes of an element'.

(ii) Calculate the relative atomic mass of magnesium.

(iii) Is it possible to separate the isotopes of magnesium by chemical means? Explain your answer.

(4 marks)

19. 2002/I/8b

Both carbon and silicon are Group IV elements in the Periodic Table.

(i) Draw the electronic diagram of a carbon dioxide molecule, showing electrons in the outermost shells only.

(ii) Explain why carbon dioxide can be used in fire fighting. *(Out of syll.)*

(iii) Explain why carbon dioxide is a gas, whereas silicon dioxide is a solid at room temperature and pressure.

(iv) Silicon can be obtained by heating silicon dioxide with carbon strongly.

(1) Write a chemical equation for the reaction involved.

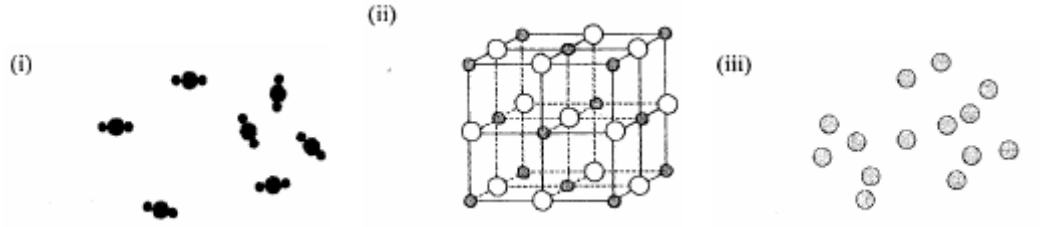
(2) Suggest ONE use of silicon. (8 marks)

20. 2003/I/1

Consider the substances listed below:

carbon dioxide	hydrogen chloride	neon
nitrogen	silicon dioxide	sodium chloride

(a) Diagrams (i), (ii) and (iii) below show the arrangements of particles, which can be atoms, ions or molecules, in some substances. For each diagram, choose ONE substance from the above list, which has the arrangement of particles as shown under room temperature and pressure.



(b) From the above list, identify ONE substance which gives an acidic solution when dissolved in water. Write the chemical equation for the reaction involved. (5 marks)

21. 2003/I/3

(a) The atomic numbers of sulphur and chlorine are 16 and 17 respectively. Draw the electronic diagrams of the following atoms:

(i) sulphur atom

(ii) chlorine atom

(b) Chlorine reacts with sulphur to form a compound with relative molecular mass of 135.2. The compound contains 52.5% of chlorine by mass.

(i) Deduce the molecular formula of the compound.

(ii) Draw the electronic diagram of the compound, showing electrons in the *outermost shells* only.

(Relative atomic masses : S = 32.1, Cl = 35.5) (6 marks)

22. 2004/I/9ai-vi

(a) A portion of the Periodic Table is shown below:

		Group							
		I	II	III	IV	V	VI	VII	0
Period	2	Li	Be	B	C	N	O	F	Ne
	3	Na	Mg	Al	Si	P	S	Cl	Ar
	4	K	Ca					Br	

(i) Identify ONE semi-metal in the above table.

(ii) Suggest why Group 0 elements seldom form compounds.

(iii) Using aluminium as an example, describe the bonding in metals. Hence, explain why metals are ductile.

(iv) Which metal and non-metal in the above table would react most vigorously with each other ?

(v) (1) The atomic number of bromine is 35. The electronic arrangement of a bromine atom can be represented as 2, 8, x, y. What are the values of x and y ? (6 marks)

23. 2005/I/1a,b,c

(a) Calcium is an element in Group II of the Periodic Table.

(i) Calcium reacts with nitrogen to form calcium nitride, which is an ionic compound. Draw the electronic diagram of calcium nitride, showing electrons in the *outermost shells* only.

(ii) Suggest a test to show that marble is a calcium-containing substance. (3 marks)

(b) Strontium (Sr) is another Group II element. It exists in several isotopic forms.

(i) What is the meaning of the term 'isotope'?

(ii) Strontium-90 (^{90}Sr) is a radioactive isotope of strontium, and is one of the dangerous by-products of nuclear fission.

Complete the table below by providing the relevant information for a ^{90}Sr atom.

	Number of protons	Number of neutrons
^{90}Sr		

(2 marks)

(c) (i) State the similarity between a calcium atom and a strontium atoms in terms of electronic arrangement.

(ii) Children's teeth require a large amount of calcium to grow. Scientists found that in areas where nuclear weapon tests were conducted above the ground, children's teeth contained a higher level of ^{90}Sr.

Suggest a reason for the findings of the scientists. (2 marks)

24. 2007/I/1

A is a compound formed from oxygen and magnesium, while *B* is a compound formed from oxygen and fluorine.

(a) Draw the electronic diagram of *A*, showing electrons in the outermost shells only. (1 mark)

(b) Draw the electronic diagram of *B*, showing electrons in the outermost shells only. (1 mark)

(c) Compare the melting points of *A* and *B*. Explain your answer. (2 marks)

25. 2008/I/1

T, **X** and **Z** are three elements in the Periodic Table, with the sum of their atomic numbers equals to 38. Moreover, both **T** and **X** are Group VII elements, while the atomic number of **T** is smaller than that of **X**.

(a) What are elements **T**, **X** and **Z** ?

T : _____

X : _____

Z : _____ (1 mark)

(b) Draw the electronic diagram of the compound formed from **T** and **X**, showing electrons in the *outermost shells* only.

(c) Discuss, with explanation, the electrical conductivity of the compound formed from **X** and **Z** with reference to the type and property of the particles in it. (2 marks)

26. 2008/I/2

Boron occurs naturally in two isotopes, ^{10}B and ^{11}B.

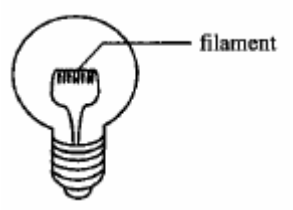
(a) What is meant by the term 'isotopes' ? (1 mark)

(b) With reference to the Periodic Table on page 20, calculate the percentage abundance of ^{11}B in nature. (2 marks)

(c) $^{10}BCl_3$ and $^{11}BCl_3$ are compounds formed respectively from the two isotopes of boron with chlorine. $^{10}BCl_3$ reacts with water to give white fumes. State, with explanation, the expected observation when $^{11}BCl_3$ is added to water. (1 mark)

27. 2008/I/12

The simplified diagram below shows a tungsten light bulb. The filament inside is made of tungsten metal (atomic number = 74). The filament can emit light by passing an electric current until it reaches an extremely high temperature. Under vacuum condition, the filament would emit tungsten particles under extremely high temperature and blacken the light bulb. To avoid this from happening, the light bulb should be filled up with gas.



(a) Describe the structure and bonding in tungsten metal with the help of a diagram. (3 marks)

(b) Apart from the property that tungsten can emit light at extremely high temperature, suggest another physical property that can render it suitable for making filament. Explain why it has this property. (2 marks)

(c) Tungsten is stable in air under normal conditions. However, it is not appropriate to fill up a tungsten light bulb with air. Explain. (1 mark)

(d) Suggest, with explanation in terms of electronic arrangement, a suitable gas for filling up a tungsten light bulb. (2 marks)

(e) Explain, from the perspective of energy, why the efficiency of tungsten light bulb is not high enough. (1 mark)